

A High Performance MEMS Thin-Film Teflon Electret Microphone

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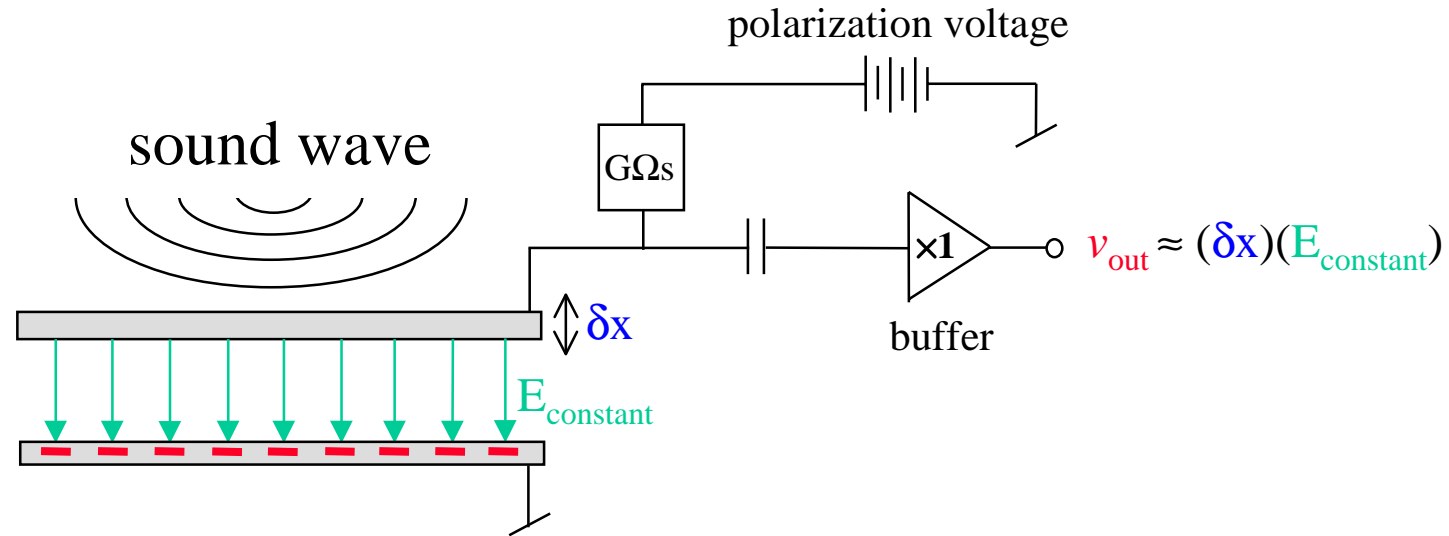
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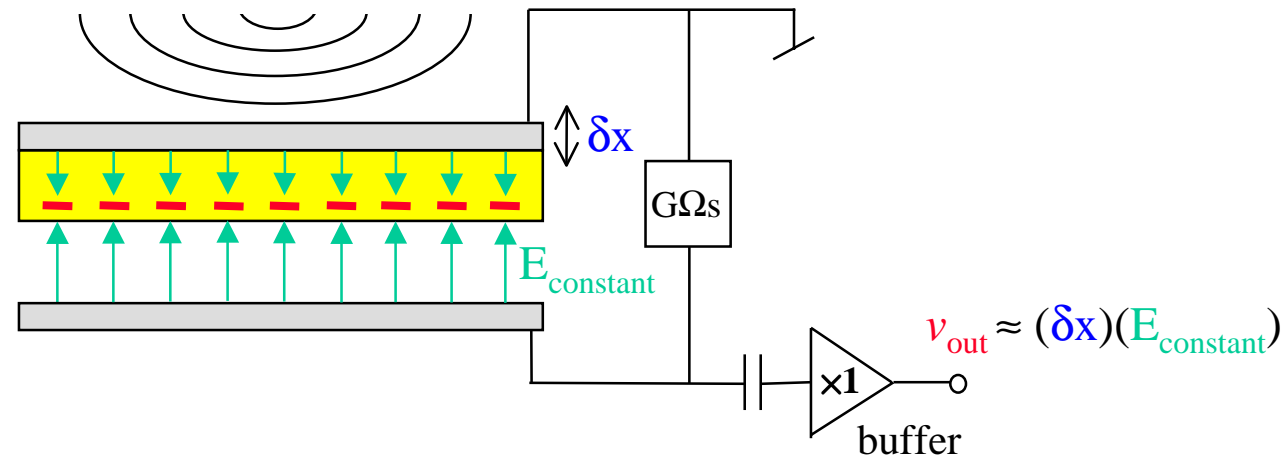
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Condenser Microphones: Principal of Operation

Externally
Biased

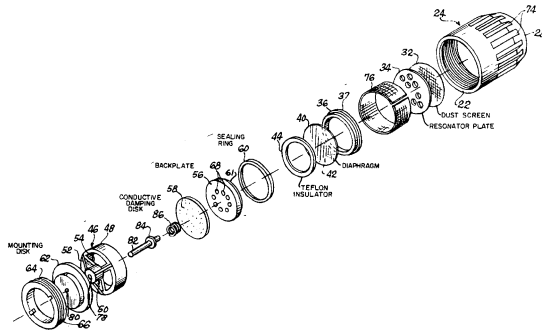


Self-Biasing
(electret)

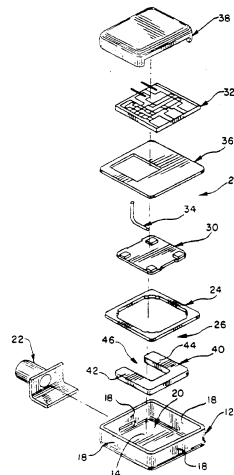


Micromachined Electret Condensor Microphones

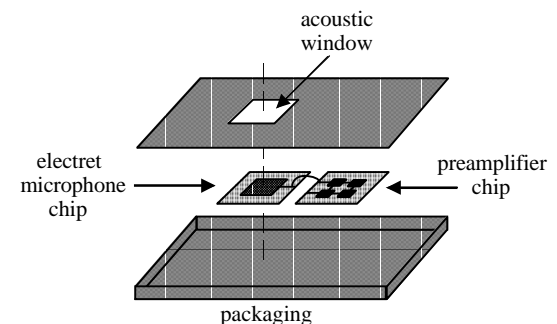
- Requires no external power source (**self-biasing**)
- Can be **mm-scale** with **high sensitivity** (10+ mV/Pa)
- **Integrable** with **on-chip electronics**
- **Mass producible** like ICs → low cost, high yield
- **Structurally simple** → increased reliability



Electro-Voice®



Knowles®



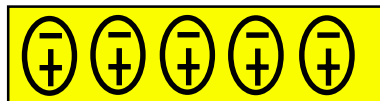
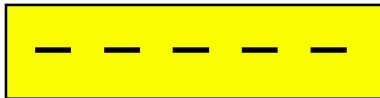
Our Envisioned
Micromachined Microphone



What is an Electret?

History

*dielectric with
trapped charge*



$\tau_{\text{decay}} =$
10's - 100's yrs

1732	<i>Electret phenomena (Gray)</i>	[slabs]
1919	<i>Wax electrets (Eguchi)</i>	[mm]
1950+	<i>PTFE, PVDF, Mylar sheet</i>	[>10 μm]
1962	<i>1st electret mic. by Sessler</i>	[6 μm]
1997	<i>Thin film Teflon electret</i>	[1 μm]

Applications

μ - microphone/speaker

μ - air filters

μ - motors & generators

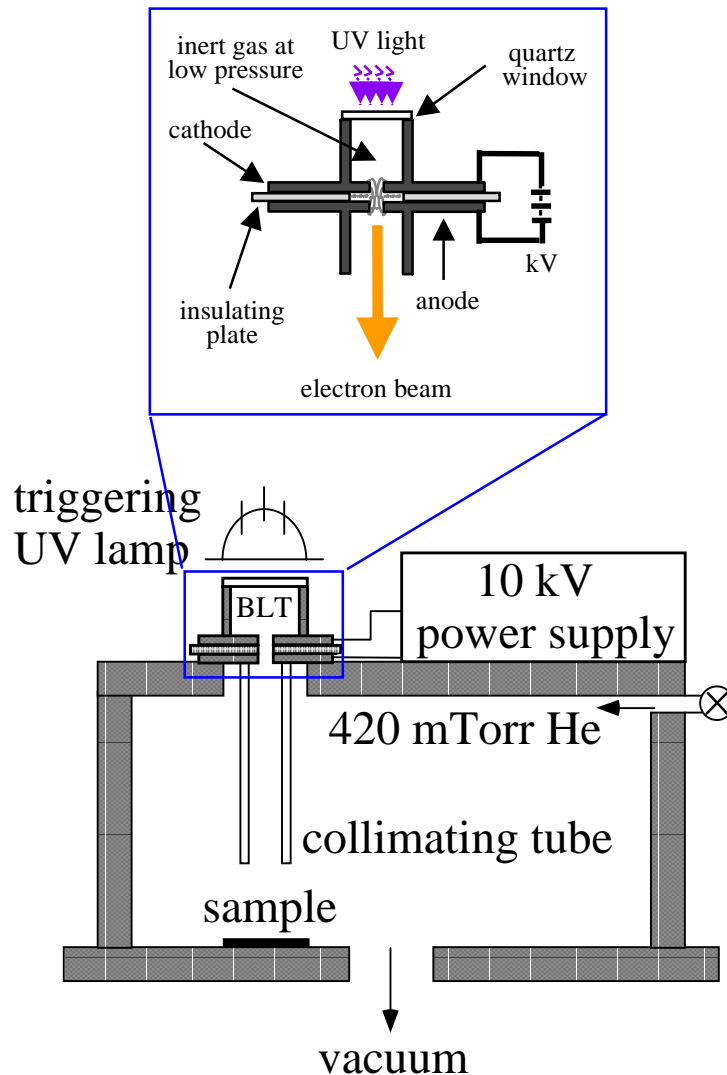


Thin Film Teflon[®] Electret Technology

<i>Material</i>	DuPont Teflon [®] AF
<i>Application</i>	Spin on, bake @ 200°C
<i>Charge Implantation</i>	Back-Lighted Thyratron pulsed electron gun (keV e^- s)
<i>Charge Stabilization</i>	Thermal annealing
<i>Charge Measurement</i>	Charge compensation method
<i>Achievable Stable Charge Densities</i>	$1 \times 10^{-5} \text{ C/m}^2$ to $8 \times 10^{-4} \text{ C/m}^2$



Charge Implantation using the BLT



Advantages

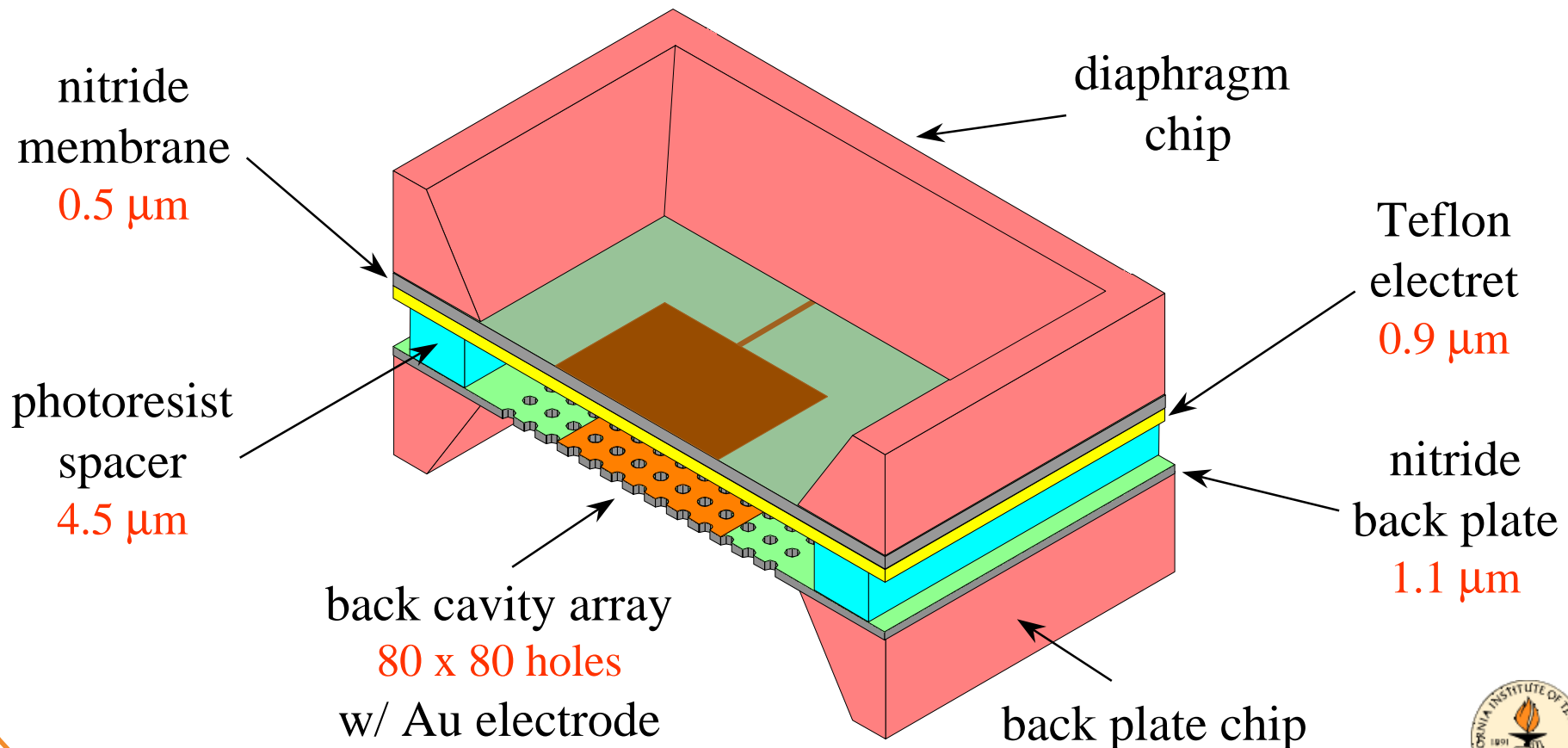
- Room temperature
- Large beam size (>mm)
- Variable energy (5 keV - 30 keV)
- High electron dose (10^{-9} - 10^{-6} C)
- High throughput
- Low Cost

MEMS Electret Microphone

Sensitivity: ~ 45 mV/Pa

Dynamic Range: less than 30 - 110+ dB SPL

THD: $<1\%$ @ 110 dB SPL, 650Hz



Microphone Diaphragm & Back Plate

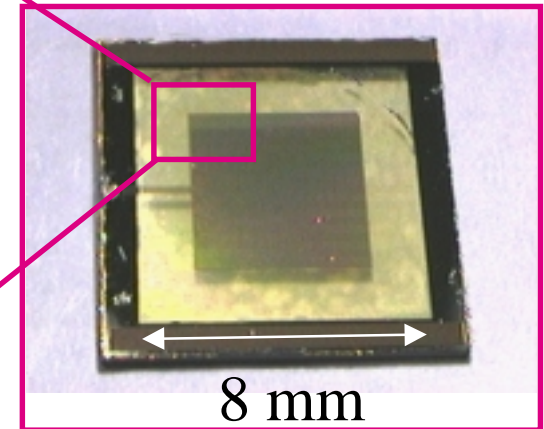
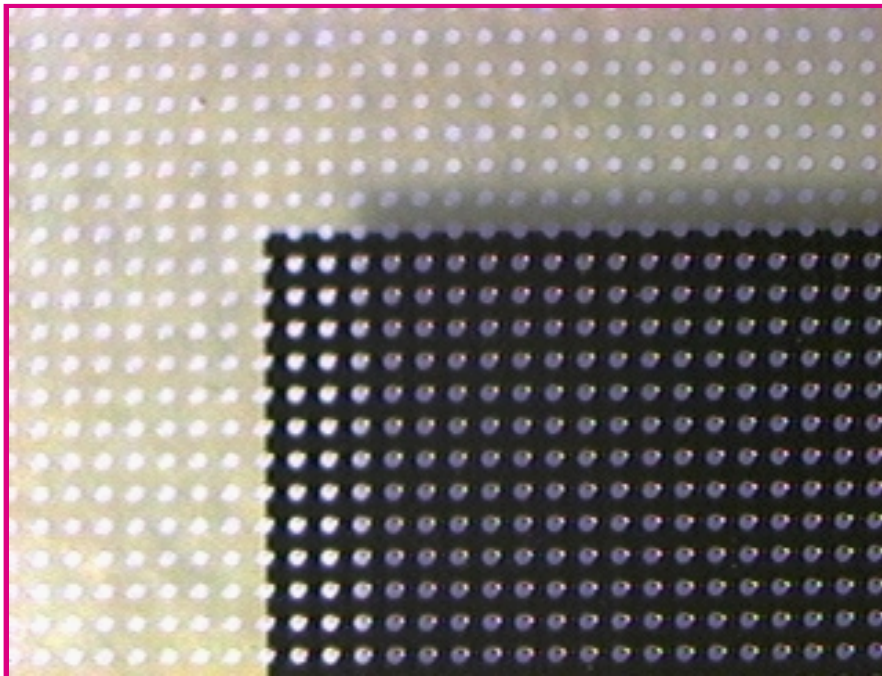
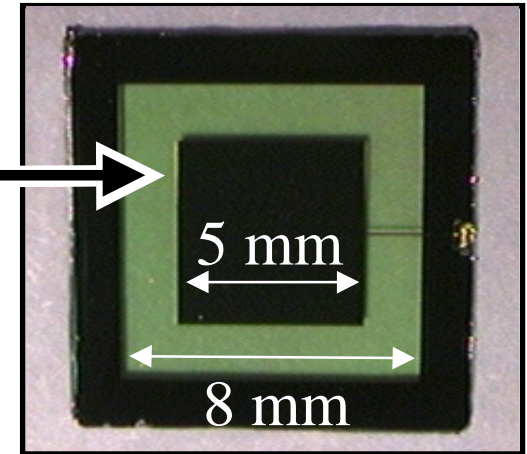
Nitride membrane die



Cr/Au electrode

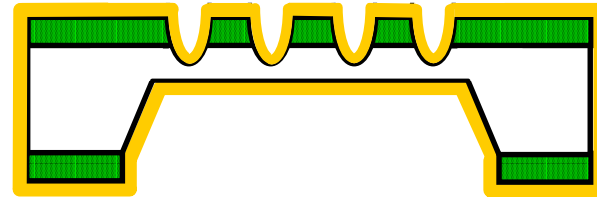
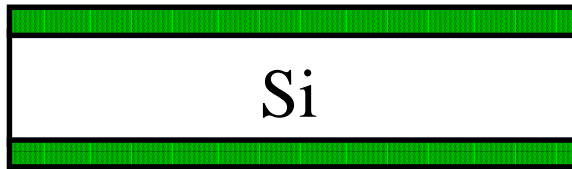


160 x 160 back cavity array



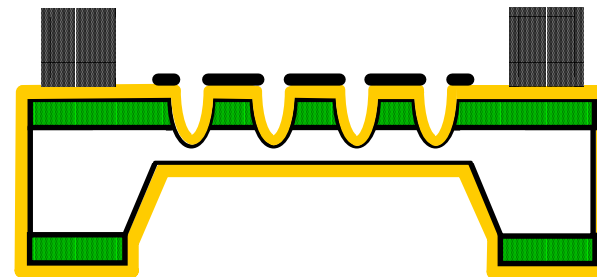
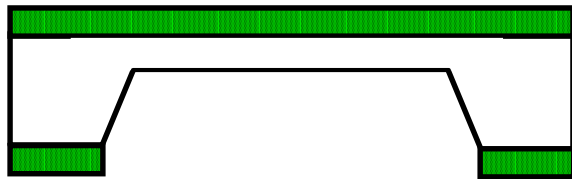
Microphone Back Plate Process Flow

nitride



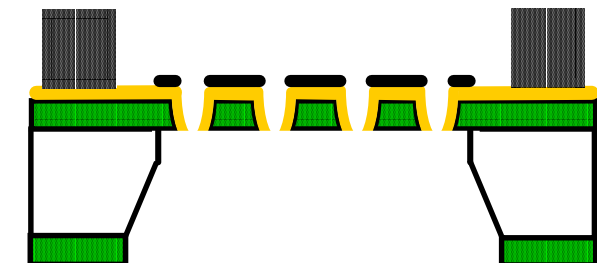
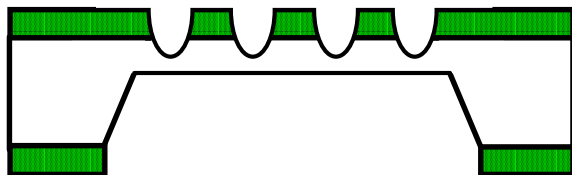
Parylene
coating

KOH
etch



PR spacer
&
electrode

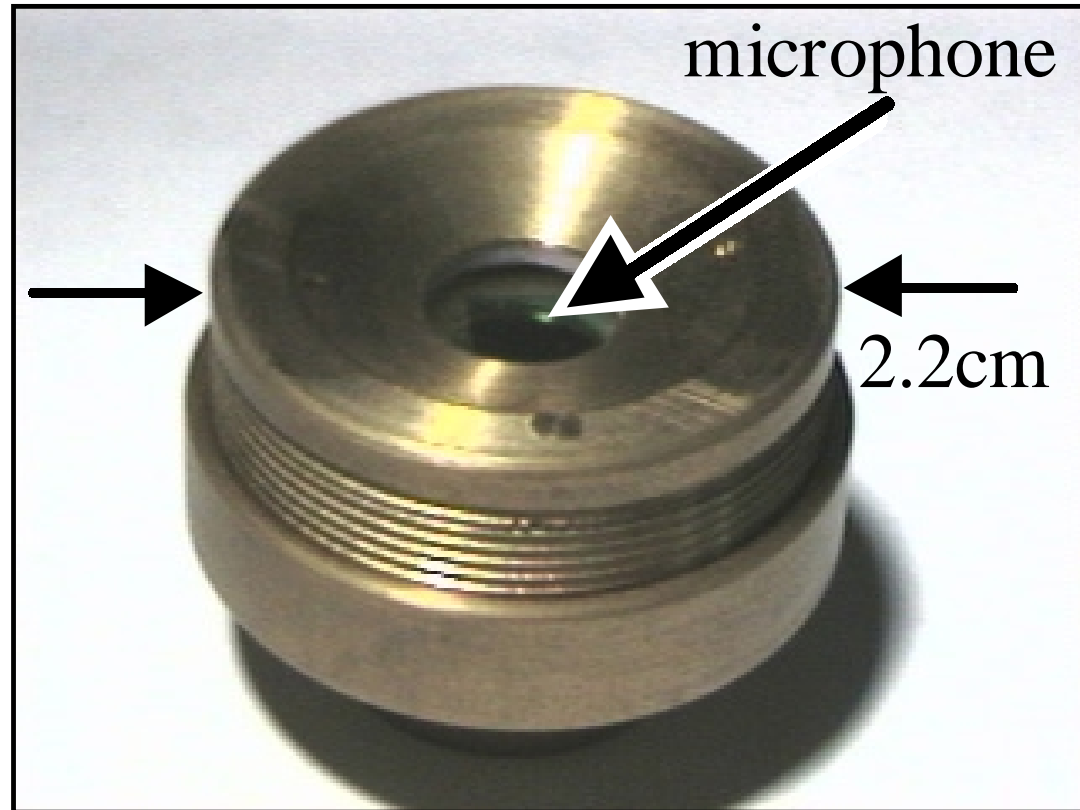
cavity
etch



Etch
Parylene &
 BrF_3 etch



Electret Microphone Package



Microphone Characteristics

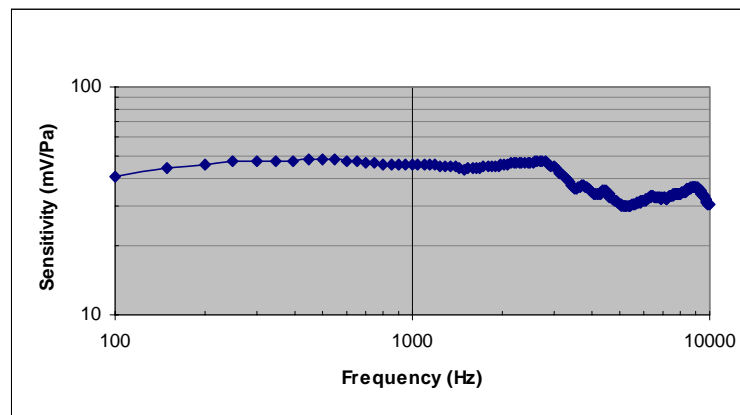
Bias Voltage: 0 V

Open-circuit Sensitivity: ~ 45 mV/Pa (150-3000 Hz)
(comparable to B&K 1/2" 4189 electret microphone!)

Frequency Range: 100 Hz - 10 kHz

Dynamic Range: less than 30 - over 110 dB SPL

THD: $<1\%$ @ 110 dB SPL, 650Hz



Frequency Response

Microphone Array for Directional Acoustics

